Deloro Mine Site Cleanup
Integrated Cleanup Plan
Final Report

Prepared for:

ONTARIO MINISTRY OF THE ENVIRONMENT

Prepared by:

CH2MHILL

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Minister of the Environment

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Executive Summary

Background

The Deloro Mine/Refinery Site, located in Eastern Ontario, began operation as a gold mine in the 1860s. Over the next 100 years, site activities also included the smelting and refining of a number of other elements including arsenic, silver, and cobalt. Activities associated with the mining, smelting, and refining of metals ceased in 1961. These historical activities at the site have resulted in significant environmental impacts to the soil, groundwater, surface water, and sediment quality both onsite and offsite.

Abandonment of the site by its owner(s) forced the Ontario Ministry of the Environment (MOE) to take control of the property in 1979 and to initiate control measures to limit the environmental impact from the site. Remedial initiatives by the MOE have resulted in reductions of arsenic loadings to the Moira River. Arsenic loading to the Moira River has been reduced by more than 80 percent from an annual average of 52.1 kg/day in 1979 to an annual average of less than 10 kg/day since 1983.

To provide further treatment, and to mitigate any unacceptable impacts on human health and the environment, CH2M HILL Canada Limited (CH2M HILL) was retained by the MOE to develop and implement a comprehensive rehabilitation program focusing on four individual areas of concern at the Deloro Mine Site. These areas included the Industrial Area, Mine Area, Tailings Area, and Young's Creek Area.

Deloro Mine Site Cleanup Objective

The overall objective of the Deloro Mine Site Cleanup is to successfully rehabilitate the mine site so as to mitigate, within reason, any unacceptable impacts on human health or the environment. The overall closure objective is intended to achieve a 90 percent reduction in arsenic discharge to the Moira River to meet current/interim Provincial Water Quality Objectives (PWQO) in the Moira River downstream of the site.

As part of this overall objective, several area-specific objectives have been developed. Achieving these objectives, in conjunction with the other area-specific objectives, will aid in the successful rehabilitation of the Deloro Mine Site.

Closure Plan for Each Area

Closure Plans have been developed for each of the four areas of the site. The Closure Plans describe the key components of the recommended rehabilitation alternatives developed for each area which have been developed to the preliminary design level. The Closure Plans will be the subject of additional public consultation and stakeholder review in addition to providing supporting documentation for regulatory reviews and applications. It is anticipated that the Integrated Cleanup Plan and/or the Final Design may need to be revised, as a result of the findings of ongoing studies such as the Site-Specific Risk Assessment (SSRA) and groundwater modelling studies. Such revisions are expected to

refine the recommended alternative for each main area of the site but not result in a fundamental change in direction. The comments and additional findings will be incorporated into the final rehabilitation strategy and implemented in the construction phase of the project.

A Closure Plan has been developed for each area of the site based on the recommended rehabilitation alternative identified in Table E.1.

TABLE E.1
RECOMMENDED REHABILITATION ALTERNATIVE FOR EACH AREA

Industrial Area:
Consolidate and cover wastes with an engineered cover augmented with groundwater and surface water flow diversion to enhance the existing collection/treatment system
Mine Area:
Relocation/consolidation of highly leachable waste (HLW) to the Industrial Area, placement of a soil cover in the remaining areas, and treatment of groundwater from the Tuttle Shaft
Tailings Area:
Cover tailings with an engineered soil cover combined with collection/treatment of groundwater and upstream surface water flow diversion
Young's Creek Area:
Full depth excavation of onsite residues, shallow depth excavation of offsite residues, residue disposal in a new onsite engineered containment facility followed by creek rehabilitation

Purpose of This Integrated Cleanup Plan

This report is an ICP that assimilates and integrates the four area-based Closure Plans to provide a comprehensive summary of the cleanup efforts planned for the entire Deloro Mine Site (and related offsite areas). In addition to summarizing the area-based plans, the ICP was developed to consider logistics and to capitalize on synergies between the various plans. The ICP includes optimization and prioritization of remedial actions across the affected areas.

Sequencing of Work Packages

The recommended cleanup plan has been divided into a series of 31 work packages which can be contracted individually or bundled. The work packages that will be addressed or implemented on a phased basis, as part of the site-wide cleanup, as well as the progress of the site-wide cleanup over the construction period, are shown in the remediation activity plans.

Key Performance Indicators

The ability of the design components of each recommended alternative to achieve or support the closure objectives presented in the ICP are examined below in terms of key performance indicators. The key performance indicators are drawn from the respective Closure Plans and are expressed in qualitative (e.g. design approach) and quantitative terms (e.g. modelling results).

All of the low-level radioactive materials will be excavated and/or covered in the Industrial Area and other areas of the site such that the radiation fields will be reduced to less than

0.12 µSv/h, the upper limit of background levels at the site, and to normal background levels of 0.03 to 0.06 µSv/h, if possible.

Industrial Area

Key performance indicators for the Industrial Area include:

- Capping of the entire Industrial Area eliminates contact of surface water runoff with highly leachable and marginally leachable wastes/soils
- The engineered cap/hybrid poplar trees (over consolidated highly leachable waste [HLW]) will allow only approximately 4 percent infiltration of annual precipitation
- The passive groundwater interceptor well network (GIWN) will:
  - Intercept approximately 960 m^3/day on unimpacted groundwater before passing through the site
  - Completely dewater wastes and overburden, together with existing pumping stations
  - Result in relatively low interference with the Deloro Village potable well (less than 2 m)
  - Minimize the potential to intercept contaminated groundwater from beneath the engineered cap
- Estimated reduction in arsenic loading to the Moira River, as a result of the waste consolidation, capping, and groundwater interception measures, are:
  - 52.1 kg/day (1979)
  - <10 kg/day (since 1983)
  - Approximately less than 1 kg/day (after cleanup to meet the overall closure objective of a 90 percent reduction in arsenic discharge to the Moira River, so as to achieve interim PWQO in the Moira River downstream of the site)
- Implementation of the recommended alternative for the Industrial Area is also expected to provide safe, long-term containment of the Industrial Area wastes, including the low-level radioactive wastes

Mine Area

Key performance indicators for the Mine Area include:

- HLW will be excavated and transferred for consolidation under the engineered cover, eliminating these sources in the Main Mine Area and the Remote Mine Areas
- Waste rock stockpiles and marginally leachable wastes/soils will be capped, minimizing leachate generation
- Increasing pumping at the Tuttle Shaft to year-round pumping will eliminate the artesian discharge of arsenic contaminated groundwater to Moira River
- Cleanup activities and year-round pumping at the Tuttle Shaft (together with the cleanup activities to be undertaken in the Industrial Area) are expected to result in very low arsenic loading to the Moira River (approximately less than 1 kg/day)
- Implementation of the recommended alternative for the Mine Area is also expected to provide safe, long-term containment of the remaining wastes/soils in the Main Mine

Area, and includes the removal of a small quantity of low-level radioactive wastes for consolidation with similar wastes in the Industrial Area

Tailings Area

Key performance indicators for the Tailings Area include:

- Engineered cover/hybrid poplar trees will allow less than approximately 10 percent of the annual precipitation to infiltrate to the underlying tailings, thereby minimizing the generation of new contaminated seepage beneath the walls of the tailings dam
- Interceptor ditch will divert upstream, non-impacted surface water from the Tailings Area, further minimizing infiltration of surface water into the tailings
- The above-noted cleanup measures, together with the pumping and treatment of contaminated seepage from beneath the walls of the tailings dam, is expected to eliminate or substantiality minimize the cobalt and copper loading from the Tailings Area to the Moira River
- Implementation of the recommended alternative for the Tailings Area is also expected to provide safe, long-term containment of the tailings, including the radioactive tailings

Young's Creek Area

Key performance indicators for the Young's Creek Area include:

- Removal of the contaminated sediments/soils, including some radioactive sediments that originated from the Tailings Area will address current risks/concerns:
  - Exposure to radiation
  - Elevated human health and ecological risk
  - Potential erosion/transport of contaminated materials downstream during severe storm events
  - Undesirable risk to public and ecological receptors in offsite portion of Young's Creek (offsite portion of Young's Creek is not fenced)
- The secure containment cell is expected to provide safe, long-term storage of these materials, including the radioactive tailings/sediments

Ackerman Property

The Ackerman property, which includes the former Ackerman Mine Site, is located south of the Deloro Mine Site on the south side of Highway 7. The property belongs to Quinte Conservation. A study (Golder, May 1995), commissioned by Quinte Conservation, of the soil and fill quality at the Ackerman Conservation Area identified arsenic deposits believed to have originated from the Deloro Mine Site. The MOE has agreed to provide Quinte Conservation with a permanent environmental solution, which will involve the receipt and permanent storage of the contaminated materials to the Deloro site from the Ackerman property.

Health, Safety, and Environmental Controls

Protection of public health and the environment is of paramount concern throughout and following the physical work proposed for the Deloro Mine Site Cleanup. Public health is viewed to encompass worker health and protection for individuals engaged in the cleanup activities as well as protection for residents near the site. This includes people living in the Village of Deloro and downstream along the Moira River. Environmental protection includes identifying risks related to potential releases during the cleanup whether through liquid releases to the Moira River, spillage of wastes during relocation, or dust/air emissions as a result of physical works at the site. The ICP outlines the provisions that are proposed as part of this comprehensive plan. This includes provisions for containment, monitoring, and mitigation. A number of specific plans and measures are proposed to address various aspects of the identified health, safety, and environmental risks including:

- Site Security and Safety Provisions
- Health and Safety Plans/Monitoring for Worker Protection
- Environmental and Community Health Protection Plan
  - Dust and Air Monitoring
  - Noise Control
  - Surface Water Protection
- Emergency Response and Preparedness Plan
- Transportation and Emergency Response Plan
- Contamination Control and Decontamination Provisions
- Extensive Monitoring Programs for two time frames:
  - Construction Phase
  - OMM Phase

The MOE will provide the emergency response and preparedness plans to the local municipalities.

Approval Requirements

The primary regulatory approvals that must be applied for and issued by the appropriate government agencies are summarized below.

As confirmation that the actual cleanup is completed according to the SSRA, a RSC application may be prepared and filed to document the cleanup. Providing there is no change to a more sensitive land use (not contemplated for the Deloro Mine Site), the filing of a RSC application is voluntary. The RSC is completed jointly by the proponent, MOE, as well as the consultant overseeing the cleanup. Alternatively, even if a RSC is not sought, the SSRA report will be reviewed by the MOE's SDB prior to site cleanup and their comments will be addressed as part of Final Design.

Other site-wide regulatory approvals that must be applied for and issued will be sought from the following agencies:

- MOE Certificates of Approval (C of As) for sewage and waste disposal; permits to take water; and Part V approval under the Provincial *Environmental Protection Act*

- The sedimentation basins planned for Young's Creek will require MOE approval under Section 53 of the Ontario Water Resources Act (OWRA)
- Conservation Authority regulations: the *Fill, Construction, and Alteration to Waterways Regulation*
- The Ministry of Natural Resources (MNR) is responsible for issuing Work Permits under several different Provincial Acts including the *Forest Fire Prevention Act*, *Lakes and Rivers Improvement Act*, and *Public Lands Act*
- The Department of Fisheries and Oceans (DFO) is responsible for the *Navigable Waters Protection Act* and the *Fisheries Act*
- The Canadian Coast Guard (CCG) will need to be consulted regarding navigable water issues
- Environmental Assessment and Canadian Nuclear Safety Commission (CNSC) Licensing will be required to manage the low-level radioactive and non-radioactive wastes on the site
- The Ontario *Heritage Act* and Ministry of Culture requirements need to be addressed by undertaking a Stage 2 archaeological assessment. This assessment is designed to fulfill the recommendation (from a completed Stage 1 assessment) that, prior to any land-disturbing activities, all areas to be disturbed should be subject to field review or detailed survey, as appropriate, in order to confirm the presence or absence of areas of archaeological potential and to identify any archaeological sites that may be present.

Even though the Crown (i.e. the Provincial Government) is exempt from the requirements of the *Mining Act,* the Closure Plans have been developed in general accordance with the requirements of the document entitled, *Rehabilitation of Mines, Guidelines for Proponents* (MNDM, 1995). The Ontario Ministry of Northern Development and Mines (MNDM) has agreed to review the Closure Plans relative to accepted standards for closure and rehabilitation of mines in Ontario, although a specific approval will not be issued.

CH2M HILL

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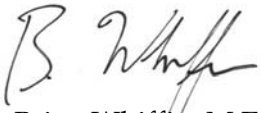

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List of Acronyms

ATP	Arsenic Treatment Plant
C of A	Certificate of Approval
CCG	Canadian Coast Guard
CEAA	Canadian Environmental Assessment Act
CNSC	Canadian Nuclear Safety Commission
COC	Contaminant of Concern
DFO	Department of Fisheries and Oceans
EA	Environmental Assessment
EAA	Environmental Assessment Act
ECHPP	Environmental and Community Health Protection Plan
EIS	Environmental Impact Study
EPA	Environmental Protection Act
GCL	Geosynthetic Clay Liner
GHASP	General Health and Safety Plan
GIWN	Groundwater Interceptor Well Network
GST	Goods and Services Tax
GUCSO	Guideline for Use at Contaminated Sites in Ontario
H&S	Health and Safety
HADD	Harmful Alteration, Disruption, or Destruction
HDPE	High-Density Polyethylene
HELP	Hydrologic Evaluation of Landfill Performance
HHRA	Human Health Risk Assessment
HLW	Highly Leachable Waste
ICP	Integrated Cleanup Plan
LEL	Lowest Effect Level
masl	Metres Above Sea Level
mbgs	Metres Below Ground Surface
MLS	Marginally Leachable Soil
MNDM	Ministry of Northern Development and Mines
MNR	Ministry of Natural Resources
MOE	Ministry of the Environment
MRCA	Moira River Conservation Authority
MTC	MOE Technical Committee
NPV	Net Present Value
NSCA	Nuclear Safety and Control Act
NWPA	Navigable Waters Protection Act
OCWA	Ontario Clean Water Agency
OMM	Operation, Maintenance, and Monitoring
OWRA	Ontario Water Resources Act
PC of A	Provisional Certificate of Approval
PLC	Public Liaison Committee
PPE	Personal Protective Equipment
PSW	Provincially Significant Wetland

PTB	Primary Treatment Building
PTTW	Permit to Take Water
PVC	Polyvinyl Chloride
PWQO	Provincial Water Quality Objectives
QC	Quinte Conservation
RA	Responsible Authority
RSC	Record of Site Condition
SDB	Standards Development Branch
SEL	Severe Effect Level
SLERA	Screening Level Ecological Risk Assessment
SPMDD	Standard Proctor Maximum Dry Density
SSRA	Site-Specific Risk Assessment
TERP	Transportation and Emergency Response Plan
TLC	Technical Liaison Committee
USEPA	U.S. Environmental Protection Agency
VEC	Valued Ecosystem Component
VSC	Valued Social Component
WCA	Waste Consolidation Area
WNSL	Waste Nuclear Substance Licence

1. Introduction

1.1 Background

A brief history of the Deloro Mine Site and the associated environmental issues that arose from more than a century of mining related activities, the need to rehabilitate the site, and the purpose and the organization of this document are provided in this section.

1.1.1 Deloro Mine Site

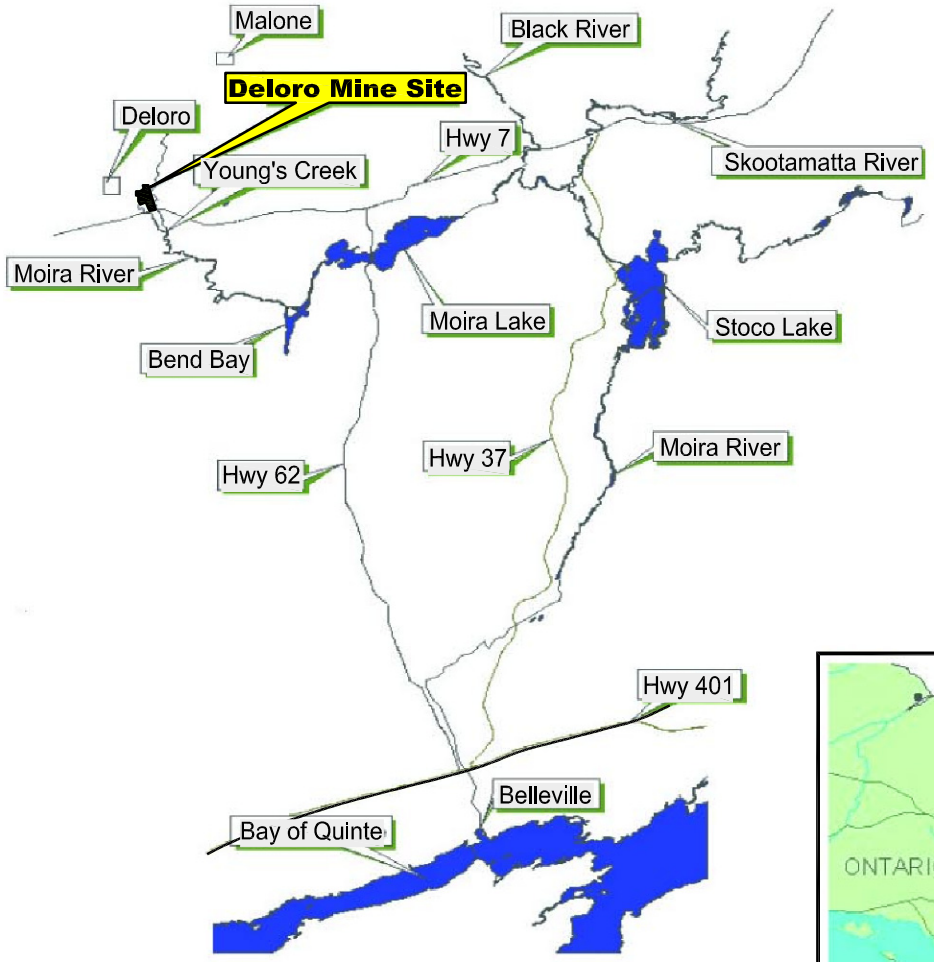
The Deloro Mine Site is located in Eastern Ontario along the banks of the Moira River (Figure 1-1) east of the Village of Deloro (Figure 1-2). The former refinery/smelter site (Industrial Area) is approximately 25 ha in area and is located adjacent to the west bank of the Moira River. The Tailings Area is located east of the Industrial Area between the east side of the Moira River and the west side of Young's Creek. The entire property, which includes the Industrial Area, Mine Area, Tailings Area, and the onsite portion of Young's Creek, is approximately 202 ha in area (CH2M HILL, February 2002).

Access to the mine site is via Deloro Road, which is accessed from Highway 7, approximately 4 km east of Marmora. The principal population centres in the area are the Village of Deloro (pop. 180), and the Villages of Marmora (pop. 1,700) and Madoc (pop. 1,400), located approximately 5 km southwest and 10 km east of the mine site, respectively.

The Deloro Mine Site began operation as a gold mine in the 1860s and evolved over the next century to mine and refine gold, as well as smelt and refine a number of other elements including arsenic, silver, and cobalt. It was the first plant in the world to produce cobalt commercially and was also a leading producer of stellite, a cobalt-chromium-tungsten alloy. Concentrates from uranium extraction were imported to the site and further processed to extract cobalt. Arsenic-based pesticides were produced from the by-products of smelting operations and continued as a main activity at the site until the market collapsed in the late 1950s.

A century of handling hazardous materials and chemicals has resulted in significant environmental degradation of the Deloro Mine Site. Large quantities of refining slag, mine tailings, calcium arsenate, and arsenical pesticides remained at the site. Fuels, chemicals, and raw materials, such as sulphuric acid, coke, lime, soda ash, caustic soda, liquid chlorine, salt, scrap iron, sodium chlorate, and fuel oil were handled at the site. Radioactive slag and tailings were produced as a result of the re-refining of by-products from uranium refining.

The Ontario government stepped in to take control of the site in 1979 due to the failure of the owner to control environmental releases. The Ministry of the Environment (MOE) has been in care and control of the site since that time. Several rehabilitation actions have been implemented at the site that have significantly reduced releases from the site. In 1979, the annual average loading of arsenic to the Moira River was 52.1 kg/day. Since the Arsenic Treatment Plant (ATP), located in the Industrial Area of the site, was put into operation in 1983, the arsenic loading to the river has been reduced by more than 80 percent, to an annual average of less than 10 kg/day. However, further work is required to reduce releases



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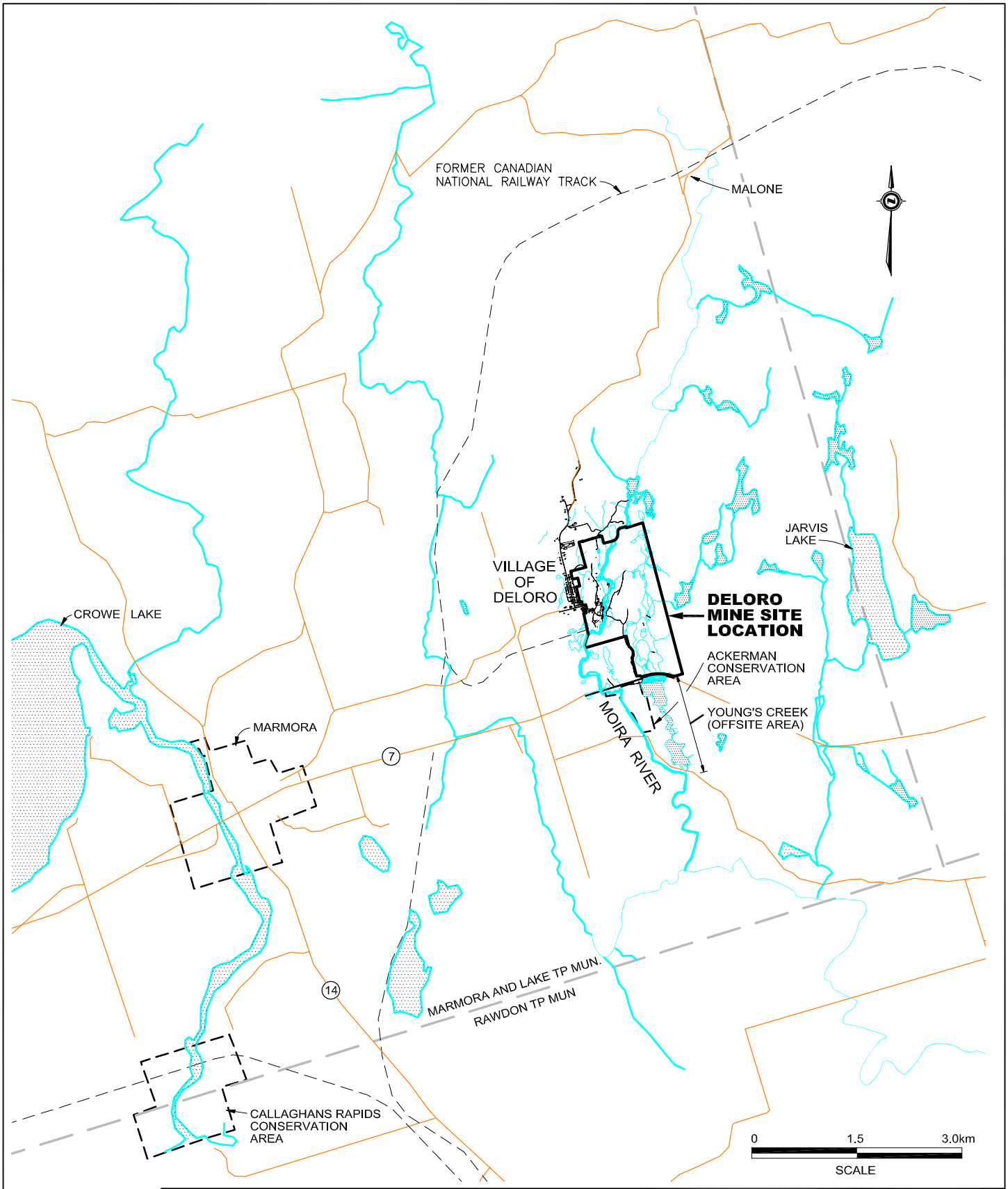
INTEGRATED CLEANUP PLAN

FIGURE 1-1
SITE LOCATION PLAN

PROJECT No. 119548



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INTEGRATED CLEANUP PLAN

FIGURE 1-2
DELORO MINE SITE LOCATION

PROJECT No. 119548

to acceptable levels and to secure the site for the long-term. CH2M HILL Canada Limited (CH2M HILL) was retained to provide consulting engineering and project management services for the Deloro Mine Site Cleanup.

1.1.2 Rehabilitation Alternatives

CH2M HILL was retained by the MOE to develop and implement a comprehensive rehabilitation program for the closure of this former mine site. As part of this comprehensive rehabilitation program, CH2M HILL evaluated a broad range of rehabilitation alternatives and identified a recommended alternative for further development for each of the four areas within the mine site's footprint, as shown in Figure 1-3. The limits of these four areas have been developed based on historical land use and waste disposal practices. The four areas are the:

- Industrial Area, where smelting and refining of various ores were carried out
- Mine Areas, on both the east and west sides of the Moira River
- Tailings Area, where by-products of the production phase were stored
- Young's Creek Area, which has been impacted from historical releases from the Tailings Area

The rehabilitation alternatives reports prepared by CH2M HILL are as follows:

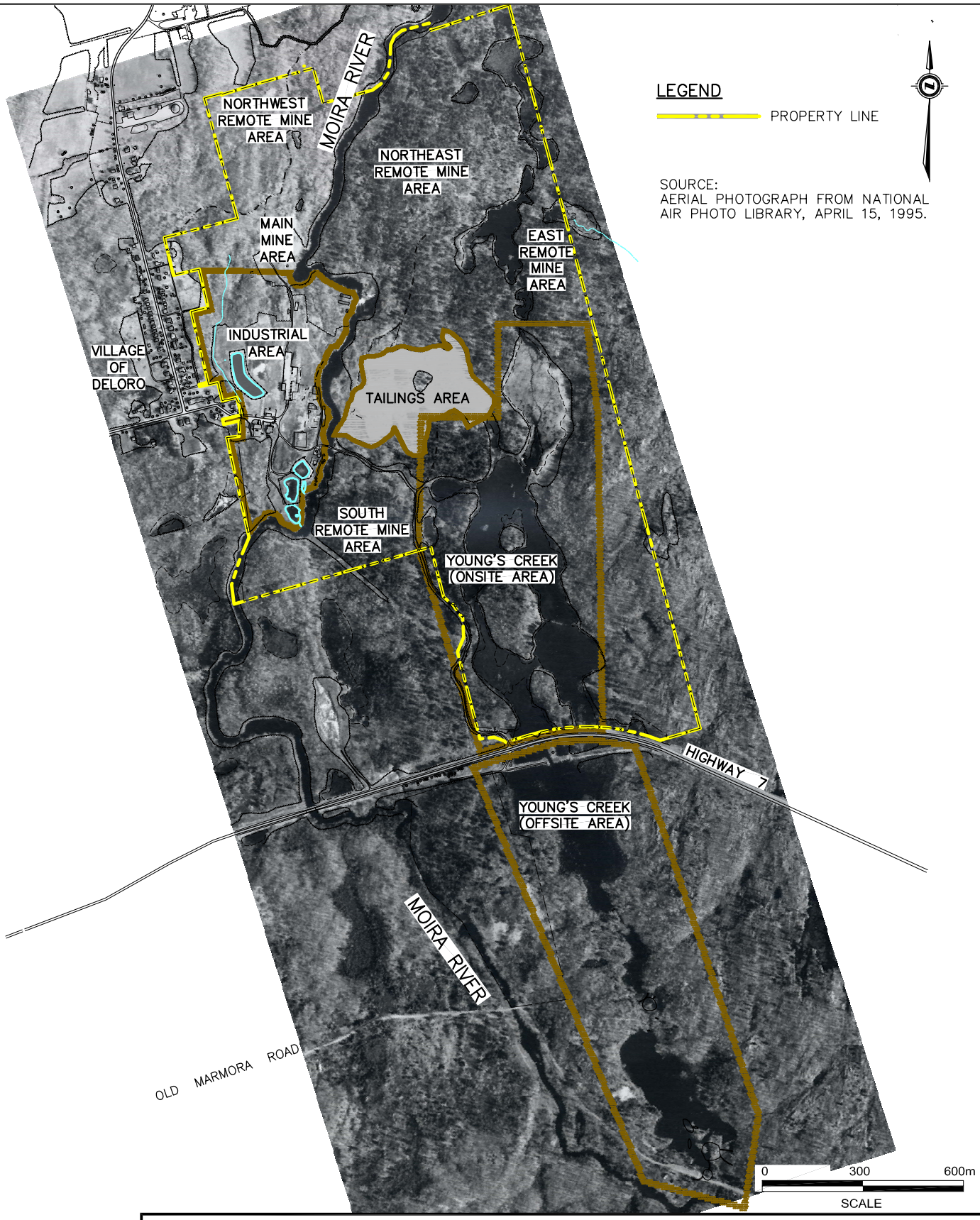
- *Deloro Mine Site Cleanup – Industrial Area Rehabilitation Alternatives* (December 2003)
- *Deloro Mine Site Cleanup – Mine Area Rehabilitation Alternatives* (October 2003b)
- *Deloro Mine Site Cleanup – Tailings Area Rehabilitation Alternatives* (October 2003a)
- *Deloro Mine Site Cleanup – Young's Creek Area Rehabilitation Alternatives* (May 2003a)

1.1.3 Development of the Recommended Alternative

Closure plans were developed to describe the recommended alternative for each area of the site. The Closure Plans will be used as a basis for public consultation and regulatory approvals. The Closure Plans for each of the four areas of the site are based on the site-wide closure objectives identified in the report entitled *Deloro Mine Rehabilitation Project – Development of Closure Criteria, Final Report* (CG&S, October 1998), including area-specific closure objectives (see Section 1.2) and the recommended rehabilitation alternatives developed for each area. The recommended alternatives are further developed in the four closure plans as follows:

- *Deloro Mine Site Cleanup – Industrial Area Closure Plan*
- *Deloro Mine Site Cleanup – Mine Area Closure Plan*
- *Deloro Mine Site Cleanup – Tailings Area Closure Plan*
- *Deloro Mine Site Cleanup – Young's Creek Area Closure Plan*

Even though the Crown (i.e. the Provincial Government) is exempt from the requirements of the *Mining Act,* the Closure Plans have been developed to satisfy, in general, the requirements of the document entitled *Rehabilitation of Mines, Guidelines for Proponents* (MNDM, 1995). This document includes provisions for the protection of the environment.



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INTEGRATED CLEANUP PLAN

PROJECT No. 119548

FIGURE 1-3: DELORO MINE/REFINERY SITE SHOWING THE INDUSTRIAL, MINE, TAILINGS AND YOUNG'S CREEK AREAS - DELORO, ONTARIO

The Integrated Cleanup Plan incorporates comments received during additional public consultation and stakeholder review and provides supporting documentation for regulatory reviews and applications. **It is anticipated that the Integrated Cleanup Plan and/or the Final Design may need to be revised, as a result of the findings of ongoing studies such as the Site-Specific Risk Assessment (SSRA) and groundwater modelling studies. Such revisions are expected to refine the recommended alternative for each main area of the site but not result in a fundamental change in direction.** The comments and additional findings will be incorporated into the final rehabilitation strategy and implemented in the construction phase of the project.

1.1.4 Purpose of this Integrated Cleanup Plan

This report is an Integrated Cleanup Plan (ICP) that assimilates and integrates the four area-based Closure Plans to provide a comprehensive summary of the cleanup efforts planned for the entire Deloro Mine Site (and related offsite areas). In addition to summarizing the area-based plans, the ICP was developed to consider logistics and capitalize on synergies between the various plans. The ICP includes optimization and prioritization of remedial actions across the affected areas.

1.1.5 Organization of Report

This report consists of seven sections, including the introduction. Section 2 summarizes the findings of the alternatives considered and the recommended rehabilitation strategy for each area. Section 3 presents the phased approach for the cleanup, and shows the final conditions once all rehabilitation is complete. Health, safety, and environmental controls are outlined in Section 4. Known and anticipated approval requirements are outlined in Section 5. The path forward to complete Stage 1 activities leading to the start of construction is described in Section 6, and Section 7 lists the references used in the preparation of this report.

1.2 Cleanup Approach and Criteria

Extensive previous investigation and evaluation has been undertaken at the Deloro Mine Site. Based on strategic decisions made by the MOE in the early 1990s, the most viable solutions for the management of residuals at the Deloro Mine Site involve onsite management through isolation and containment techniques in which mitigative action is directed at risk reduction. In this approach, risks to both human health and the environment are considered under both the current and reasonably expected future land uses. Remedial action is then undertaken to reduce any unacceptable risks to humans or the environment. This approach has been recognized as an option in the MOE's *Guideline for Use at Contaminated Sites in Ontario* (GUCSO) (MOE, 1997), in which it is referred to as the Site-Specific Risk Assessment (SSRA). The SSRA is the approach selected by the MOE as the proponent for the Deloro Mine Site rehabilitation.

The strategic direction for site cleanup, involving the onsite management of wastes through isolation and containment methods as primary remediation techniques, is described in the report entitled *Deloro Mine Rehabilitation Project – Development of Closure Criteria, Final Report* (CG&S, October 1998). This translates into the following project objective:

To successfully rehabilitate the Deloro Mine Site to mitigate any unacceptable impacts on human health or the environment in compliance with relevant environmental policies and regulations.

The overall objective of the Deloro Mine Site Cleanup is to successfully rehabilitate the mine site to mitigate, within reason, any unacceptable impacts on human health or the environment. As part of this overall objective, site-wide closure objectives have been developed as follows:

1. Reducing the loading of arsenic and other contaminants to the Moira River
2. Complying with appropriate regulations and policy
3. Satisfying the general intent of the *Mining Act* and related draft regulations
4. Reducing/controlling impact/risk to acceptable levels
5. Demolishing unneeded buildings to ground level
6. Prioritizing remedial action implementation according to risk reduction
7. Minimizing perpetual operation and maintenance
8. Restoring the site to reflect its natural surroundings
9. Securing the site for the indefinite future
10. Managing the wastes over the smallest possible area

The overall closure objective is intended to achieve a 90 percent reduction in arsenic discharge to the Moira River to achieve current/interim Provincial Water Quality Objectives (PWQO) at the intersection of the Moira River and Highway 7 (CG&S, October 1998). Monitoring will be completed to assess actual performance. Contingency measures have been incorporated as part of the recommended alternative for each area of the site and are further developed as part of the Closure Plans. These site-wide closure objectives were further refined into area-specific closure objectives for each area of the site (Table 1.1).

TABLE 1.1
CLOSURE OBJECTIVES FOR EACH AREA OF THE DELORO MINE SITE

Industrial Area
1. Develop a rehabilitation closure plan supported by a SSRA
2. Develop/implement risk reduction plans according to site-wide priorities
3. Remove wastes and residues from the area impacted by the design flood event
4. Provide flood protection for wastes/residues outside the design flood event
5. Manage radioactive materials to reduce radiation at ground surface to background levels
6. Cover and grade wastes/residues with material suitable to minimize infiltration
7. Isolate wastes/residues to eliminate, to the extent possible, releases to the environment according to the site-wide priorities
8. Co-manage wastes of similar risk (i.e. consolidate higher risk wastes and provide a suitably high degree of containment)
9. Design life for engineered facilities consistent with accepted design practice
Mine Area
1. Develop a rehabilitation closure plan supported by a SSRA
2. Develop/implement risk reduction plans according to site-wide priorities
3. Consolidate contaminated (heavily impacted) materials into limited areas of the site where appropriate
4. Restore closed mine areas to blend in with native conditions (current natural surroundings)

TABLE 1.1
CLOSURE OBJECTIVES FOR EACH AREA OF THE DELORO MINE SITE

Tailings Area
1. Develop a rehabilitation closure plan supported by a SSRA
2. Develop/implement risk reduction plans according to site-wide priorities
3. Implement measures to eliminate exposed wastes at ground surface
4. Manage contaminated groundwater/seepage/runoff
5. Promote revegetation of the area to match native conditions (i.e. to match current natural surroundings)
6. Contain tailings for the long-term, consistent with accepted design practice
7. Provide assurance of dam stability through testing and, if required, dam stabilization
Young's Creek Area
1. Develop a rehabilitation closure plan supported by a SSRA
2. Develop/implement risk reduction plans according to site-wide priorities
3. Implement measures to reduce potential exposure of contaminated sediments to human and environmental receptors
4. Implement measures to prevent increased contaminant loading to the Moira River due to re-suspension of residual contaminated material
5. Restore area to match surrounding conditions and in accordance with Ministry of Natural Resources (MNR) policies and requirements
6. Design life for engineered facilities consistent with accepted design practices

1.3 Related Reports and Studies

A list of the reports and other documents referenced in this document is provided in Section 9. Related reports and studies are on public record and available for review from the Kingston MOE office. The primary documents used in the developing the ICP are the Alternatives Reports and Closure Plans for each of the four areas listed above. These documents will be available for downloading from the MOE Web site at http://www.ontario.ca/delorominesite in the fall of 2004.

1.4 Alternatives Reports

The Deloro Mine Site Cleanup is being conducted according to the GUCSO (MOE, 1997) following the SSRA option. (As of October 1, 2004, the guideline will be incorporated into regulation under O. Reg. 153/04.) The approach has been adapted or enhanced to meet other regulatory or best management practices including the *Canadian Environmental Assessment Act* (CEAA).

A process was developed to generate potential remedial alternatives and select a recommended alternative for each of the four areas of the Deloro Mine Site. This process is described in the Alternatives Report for each area. Initially, conceptual remediation methods that could have addressed some or all of the issues were evaluated with a screening process to identify which had the greatest potential to address the issues at the site, either alone or in combination with other methods. Improbable methods that did not have significant potential to contribute to a viable solution were eliminated early in the process. This resulted in a number of primary remediation methods that were retained for further evaluation.

The primary methods and enhancing features were combined to create the comprehensive remediation alternatives addressing all of the environmental issues in each area. The full

range of comprehensive remediation alternatives considered in each area of the site is provided in Table 1.2.

TABLE 1.2
COMPREHENSIVE REMEDIATION ALTERNATIVES CONSIDERED FOR EACH AREA OF THE SITE

Industrial Area
1. Consolidate and cover
2. Consolidate and cover – Ground/surface water flow diversion
3. Consolidate and cover – Ground/surface water flow diversion, selected solidification
4. Consolidate and cover – Ground/surface water flow diversion, selected offsite disposal
5. Consolidate and cover – Ground/surface water flow diversion, enhanced groundwater collection
6. Consolidate and cover – Ground/surface water flow diversion, selected solidification, enhanced groundwater collection
7. Consolidate and cover – Ground/surface water flow diversion, selected offsite disposal, enhanced groundwater collection
8. Cap/cover in place
9. Cap/cover in place – Ground/surface water flow diversion
10. Cap/cover in place – Ground/surface water flow diversion, selected solidification
11. Cap/cover in place – Ground/surface water flow diversion, selected offsite disposal
12. Cap/cover in place – Ground/surface water flow diversion, enhanced groundwater collection
13. Cap/cover in place – Ground/surface water flow diversion, selected solidification, enhanced groundwater collection
14. Cap/cover in place – Ground/surface water flow diversion, selected offsite disposal, enhanced groundwater collection
15. Full encapsulation
16. Full encapsulation – Enhanced groundwater collection
Mine Area
Main Mine Area
1. Increase pumping from Tuttle Shaft; remove highly leachable waste (HLW) and fill excavation; cover entire affected soil/concentrated waste area with armour rock (enhancement), geofabric, clay, topsoil, and then vegetate
2. Increase pumping from Tuttle Shaft; remove HLW and fill excavation; cover waste rock with geofabric, clay, topsoil, and then vegetate; cover only heavily impacted soil/concentrated waste areas with armour rock (enhancement), geofabric, clay, topsoil, and then vegetate
3. Increase pumping from Tuttle Shaft; cover waste rock with geofabric, clay, topsoil, and then vegetate; excavate and dispose of heavily impacted soil and HLW; cover excavated area with clay, topsoil, and then vegetate
Remote Mine Area
1. Cover waste rock with geofabric, clay, topsoil, and then vegetate
Tailings Area
1. Cover the surface of the area with soil and vegetation
2. Cover the surface of the area with soil and vegetation, and divert surface runoff away from the area
3. Cover the surface of the area with soil and vegetation, and collect and treat contaminated seepage and groundwater using a natural treatment system
4. Cover the surface of the area with soil and vegetation, and collect and treat contaminated seepage and groundwater at the existing onsite ATP
5. Cover the surface of the area with soil and vegetation, divert surface runoff away from the area, and collect and treat contaminated seepage and groundwater using a natural treatment system
6. Cover the surface of the area with soil and vegetation, divert surface runoff away from the area, and collect and treat contaminated seepage and groundwater at the existing onsite ATP

TABLE 1.2
COMPREHENSIVE REMEDIATION ALTERNATIVES CONSIDERED FOR EACH AREA OF THE SITE

Young's Creek Area
1. Shallow excavation, disposal onsite, creek rehabilitation with optional enhancing features: – In-place capping – Flow regulation
2. Deep excavation, disposal onsite, creek rehabilitation

These comprehensive remediation alternatives were subsequently evaluated in a two-step process. The screening level evaluation again served to eliminate comprehensive remediation alternatives (as opposed to conceptual remediation methods that had been previously screened) that were unlikely to meet all of the remediation needs for the area. This second level of screening led to a short list of comprehensive remediation alternatives that were the subject of a more detailed evaluation. The detailed evaluation led to the identification of a recommended remediation alternative, which was developed further in the Closure Plan for each area.

1.5 Summary of the Recommended Alternatives

The recommended rehabilitation alternative for each area of the site is identified in Table 1.3 and outlined further in Section 2.

TABLE 1.3
RECOMMENDED REHABILITATION ALTERNATIVE FOR EACH AREA

Industrial Area
Consolidate and cover wastes with an engineered cover augmented with groundwater and surface water flow diversion to enhance the existing collection/treatment system
Mine Area
Relocation/consolidation of HLW to the Industrial Area, placement of a soil cover in the remaining areas and treatment of groundwater from the Tuttle Shaft
Tailings Area
Cover tailings with an engineered soil cover combined with collection/treatment of groundwater and upstream surface water flow diversion
Young's Creek Area
Full depth excavation of onsite residues, shallow depth excavation of offsite residues, residue disposal in a new onsite engineered containment facility followed by creek rehabilitation

1.6 Closure Plan Contents

The Closure Plans referenced in Section 1.1.3 contain information pertaining to the design and implementation of the recommended alternatives, including:

- Site security and safety
- Building demolition
- Waste isolation and containment
- Water management
- Mine workings, crown pillars, and surface workings

- Work package identification and sequencing
- Anticipated construction impacts and mitigation measures
- Final site grading
- Site rehabilitation and revegetation
- Implementation schedule
- Cost opinion of work packages associated with each closure plan
- Health hazard assessment
- Environmental and community health protection plan
- Operation and maintenance requirements
- Monitoring programs
- Expected post-closure conditions and uses